

WORLD-GENERATION

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CLASS OF 2015



Rich Voorberg
SIEMENS



Kim Greene
SOUTHERN



Lorraine Bolsinger
GE



Bill Buffa
MHPSA



Eileen Kauffman
TRAVELERS



Tom Alcide
SAFT



Lou Lambruschi
PARKER HANNIFIN



Dan Girard
S&C ELECTRIC



Scott Henneberry
SCHNEIDER ELECTRIC



Bill Arvan
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Stephane Dufrenne
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TABLE OF CONTENTS

PUBLISHER'S LETTER	pg. 3
RICH VOORBERG, EXECUTIVE VICE PRESIDENT	pg. 4
KIMBERLY S. GREENE, EXECUTIVE VICE PRESIDENT, COO	pg. 5
LORRAINE BOLSINGER, PRESIDENT, CEO	pg. 6
BILL BUFFA, SENIOR VICE PRESIDENT	pg. 8
EILEEN KAUFFMAN, VICE PRESIDENT	pg. 9
TOM ALCIDE, PRESIDENT	pg. 10
LOU LAMBRUSCHI, MARKETING COMMUNICATIONS AND E-BUSINESS MANAGER	pg. 11
DAN GIRARD, DIRECTOR	pg. 13
SCOTT HENNEBERRY, VICE PRESIDENT	pg. 14
BILL ARVAN, GENERAL FACILITY MANAGER	pg. 15
STEPHANE DUFRENNE, PRESIDENT	pg. 16
STEPHEN WIERZBICKI, PRESIDENT	pg. 17
BRETT GALURA, VICE PRESIDENT	pg. 18
JIM GREENWOOD, PRESIDENT AND CEO	pg. 19
STEWART PRAGER, DIRECTOR	pg. 20
DR. H. R. HUIJIAK, PROFESSOR	pg. 21



Dick Flanagan
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It's a pleasure to introduce World-Gen's Class of 2015, the 16th Class of the Millennium. The Class of 2015 tells us where the energy markets are heading.

Rich Voorberg of Siemens tells us on page 4 that the recent acquisition of the Rolls-Royce energy division and the pending acquisition of Dresser-Rand will significantly strengthen Siemens' position in distributed generation.

The way Southern produces and delivers power is changing more quickly than ever before. It is important that utilities drive enhancements to energy innovation, Kim Greene points out on page 5.

Lorraine Bolsinger says on page 6 that GE has a country-by-country approach for distributed power defined as power generated at or near the point of use on or off the grid.

William Buffa of Mitsubishi Hitachi Power Systems America explains on page 8 that the energy and environment division tries to understand what a power producer client wants to achieve and provides solutions.

Eileen Kauffman shares on page 9 that Travelers created Travelers Renewable Energy Practice to improve the way six of its businesses support the rapidly changing and special needs of renewables.

Tom Alcide highlights the building block process of Saft's new Jacksonville, FL battery factory on page 10. 4,340 solar panels generate a third of the plant's power requirements.

Lou Lambruschi asserts on page 11 that Parker Hannifin's Energy Grid Tie Division focuses on power conversion for renewable energy and micro-grid energy storage.

Dan Girard announced on page 13 that energy storage is the only one capable of balancing power supply and demand instantaneously in milliseconds rather than tens of minutes.

Scott Henneberry tells us on page 14 that Schneider Electric has been involved in the development, and operation of micro-grids which could be called virtual power plants.

Bill Arvan hosted World-Gen to a tour of the nation's first new waste to energy power plant to be built in twenty years. The 95 megawatt Palm Beach, FL facility has a 20 year PPA from Florida Power and Light. See page 15.

Stephane Dufrenne explains on page 16 that the Energy Freedom Loan is a unique turnkey financing solution for homeowners, designed to remove common financial barriers to solar adoption.

Stephen Wierzbicki looks at the future of geothermal heating and cooling on page 17 in the new construction and retrofit markets.

Brett Galura sees energy storage as a cost competitive provider to manage

(continued page 21)

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RICH VOORBERG



*Executive Vice President
Siemens Power Generation Services*

Rich Voorberg serves as Executive Vice President of Distributed Generation and Compressors for Siemens' Power Generation Services. Voorberg is based in Orlando, Florida, and his principal region of operation is the United States and Canada. His group is playing a pivotal role in Siemens on account of Siemens' recent acquisition of the Rolls-Royce energy portfolio and the pending acquisition of Houston-based Dresser-Rand Group, a major supplier to the oil and gas industry.

Born in Hamilton, Ontario to parents of Dutch extraction, Voorberg began at Westinghouse, the division for which Voorberg worked later being sold to Siemens. He started in field service and traveled the world maintaining and repairing turbines and compressors, a "great learning experience," he recalls, "like running your own business and sometimes from very remote places."

GLOBETROTTER EXPERIENCE

In the 1990s, Voorberg's globetrotting continued as his experience working in the field provided him with a wealth of knowledge and expertise that would lead him to new and exciting opportunities at Siemens. Voorberg managed turbine assembly at a Siemens plant in the late 1990s that quickly ramped up production and tripled the number of gas turbines a year.

Later, from offices in Germany, he managed a biomass construction project in

Scotland, leading a diverse project team with members from a number of European countries including Finland, Sweden, Great Britain, Germany and Scotland. He later had an opportunity to lead a team that designed and constructed a new gas turbine manufacturing center next to the existing Siemens factory in Charlotte and then managed a network of repair shops servicing the substantial fleet of Siemens gas and steam turbines and generators.

Now in Orlando, Voorberg's current role is leading Siemens' operations in North America for the power generation services division's distributed generation and compressors business unit.

His responsibilities extend from gas turbines up to 70MW to steam turbines up to 250MW. "We now have a very strong footprint in North America," he says. "We are poised and ready to grow our business, grow our capabilities, and improve our service operations at every level."

ROLLS-ROYCE INKED

Voorberg says that the recent acquisition of the Rolls-Royce energy division and the pending acquisition of Dresser-Rand will significantly strengthen Siemens' position in the oil and gas industry, particularly in the United States, and in distributed generation.

Rolls-Royce specialized in manufacturing and servicing aero derivative turbines. These smaller turbines, from 5 to 65 MW, have a number of advantages that Voorberg's group finds appealing and that fit nicely with Siemens' established portfolio of power generation products and services. In particular, they operate in the growing market for distributed generation, an area where Siemens sees great promise in North America. Voorberg says these units can fire up and begin producing up to 65 MW in as little as 10 minutes.

In New York City area, for example, these units are taking advantage of peaking opportunities in the market, able to stop and start three or four times a day for optimal efficiency. Aero derivative turbines can run on either natural gas or liquid fuel, normally using the latter as a backup. Voorberg points out that the aero derivative turbines

could become popular in the American West, where reliance is growing on wind and solar power. "When the wind subsides or the sun fades," he says, "these kinds of turbines can step in quickly to keep the power up."

Also indicating Siemens' focus on expanding its footprint in oil and gas, Voorberg points out that Lisa Davis is now heading Siemens' energy business out of Houston, the first member of Siemens' Managing Board to operate outside of Germany and an experienced oil and gas industry executive. "This shows a real commitment by Siemens to the American oil and gas and distributed generation markets," he asserts.

EMPHASIS ON REGIONALIZATION

Voorberg points to other and developing advantages of his service group in Canada and the United States. "We have 25 district offices in the region," he says, "with approximately 3,000 engineers and technicians. This emphasis on regionalization allows us to quickly and efficiently respond to issues, and, if necessary, put someone on a customer's site within hours, if not less. Our people are living and working where our customers live and work and therefore can have a clear understanding of the business environments in which our customers operate. This close collaboration with our customers," he goes on to say, "is the key to helping them keep their assets performing optimally for many years to come."

Voorberg points out another customer-focused advantage within Siemens' distributed generation services portfolio: Siemens' remote monitoring and diagnostics services. "With remote diagnostics," says Voorberg, "not only can we see and react to issues proactively, but we can also watch for trends based on an individual turbine's performance as well as from Siemens' entire fleet for that particular turbine model obtained under various operating conditions.

For example, by closely analyzing the data from our diagnostics center, we can inform a customer of a potential issue before it becomes a major one. Then, working closely with them, we can provide the

(continued page 22)

KIMBERLY S. GREENE



Executive Vice President and Chief Operating Officer
Southern Company

As an energy executive with more than two decades in the industry, Kimberly S. (Kim) Greene has seen the world of energy from multiple angles. After starting her career with Southern Company in 1991 as a mechanical engineer, Greene progressed through many areas of engineering, operations and finance.

In 2007, Greene returned to her home state of Tennessee and held several key executive roles with the Tennessee Valley Authority (TVA), including chief financial officer and chief generation officer. In early 2013, Greene returned to Southern Company as president and CEO of its Southern Company Services subsidiary. Last year she was named executive vice president and chief operating officer for Southern Company. *World-Gen* got Kim's perspective on the industry as a member of the Class of 2015.

WORLD-GEN: KIM, YOU'VE BEEN ON MANY DIFFERENT SIDES OF THE INDUSTRY AS AN ENERGY TRADER, A MEMBER OF A GOVERNMENT-OWNED UTILITY AND NOW (AGAIN) AT SOUTHERN COMPANY, ONE OF THE NATION'S LARGEST REGULATED UTILITIES. WHAT ARE SOME OF THE MORE IMPORTANT DIFFERENCES AND SIMILARITIES YOU SEE BETWEEN THESE AREAS?

Kim Greene: I have been fortunate to work at two great companies in Southern Company and TVA. Through these experiences – as well as my broader industry involvement – I have come to appreciate that many utilities share Southern Company's commitment to provide customers clean, safe, reliable and affordable power. However different companies describe this common commitment, our collective ability to deliver exceptional service helps improve the quality of life for all Americans.

The regulatory environment in which Southern Company's utilities operate provides the framework to best meet customers' evolving energy needs. Like our regulators, Southern Company is committed to provide high reliability at a low cost to customers. Our utilities' ability to achieve this goal while maintaining industry-leading customer satisfaction provides for the kind of constructive regulation necessary for making critical, capital-intensive investments that best serve the long-term interests of customers.

WORLD-GEN: OVER THE NEXT FIVE TO TEN YEARS, WHAT DO YOU SEE AS THE BIGGEST CHALLENGES THE INDUSTRY FACES AS IT SEEKS TO FULFILL THE MISSION YOU JUST MENTIONED?

Kim Greene: It's safe to say that Thomas Edison wouldn't recognize the electric industry today. Due to changing technologies, regulations and customer expectations, the ways we produce and deliver power are changing more quickly than ever before. It is important that utilities drive enhancements to the ways we produce and deliver power through an ongoing commitment to energy innovation.

Southern Company approaches energy innovation as we do other business decisions – by putting our customers at the center of everything we do. We have spent more than 40 years finding real solutions to America's energy challenges, through our research and development program.

For example, amid evolving environmental regulations, subsidiary Mississippi Power is developing a 21st century coal

plant – the Kemper County energy facility – that will incorporate proprietary coal gasification technology designed to generate power using native Mississippi lignite while removing 65 percent of carbon emissions – resulting in an emissions profile comparable to a similarly sized natural gas plant. In developing this technology, we believe we have found a way forward for coal in America and around the world.

In terms of changing customer expectations, one of the most notable focus areas today is the increased interest in distributed generation and net metering. While some view these as challenges to the industry, we see an opportunity to develop new programs to better serve those interested in emerging technologies while maintaining our commitment to provide affordable electricity to all customers.

WORLD-GEN: SO, IN LIGHT OF THOSE CHALLENGES AND ALSO CONSIDERING WE SEEM TO BE FACING A FUTURE OF VERY LOW NATURAL GAS PRICES, PRESSURES TO INCREASE RENEWABLE GENERATION OPTIONS AND A CONTINUED RELUCTANCE TO ADD LARGE OR SMALL NUCLEAR ASSETS, WHAT DO YOU SEE THE FUTURE MIX OF OUR GENERATION OPTIONS?

Kim Greene: We are focused on our customers, and we know that avoiding a generation mix that is too dependent on any one fuel source helps protect them against volatile fossil fuel prices. Utilities can deliver customer value by developing and leveraging the diverse generating fleets.

As of the end of 2014, the Southern Company system generated 40 percent of our electricity from coal, 40 percent natural gas, 16 percent from nuclear and 4 percent from renewables. In recent years, we generated 70 percent of electricity from coal and 35 percent from natural gas. This dramatic shift from coal to gas is delivering customers the benefits of today's low natural gas prices while preserving the flexibility to put the lowest-cost generation options to work

(continued page 23)

LORRAINE BOLSINGER



*President & CEO
GE's Distributed Power*

WORLD-GEN: LAST YEAR, GE PLEDGED \$1.4 BILLION IN INVESTMENTS FOR DISTRIBUTED POWER AND ASKED YOU TO LEAD THE BUSINESS. HOW HAS THAT INVESTMENT MATERIALIZED SINCE THEN?

Lorraine Bolsinger: We've continued to invest in our current products and have the broadest gas-fired portfolio worldwide. We're now expanding that portfolio with new products and services. This expansion includes the J920 gas engine, which has the highest simple-cycle efficiency in its class – 49 percent – and up to 95 percent efficiency in combined heat and power (CHP) applications. We're having success with the J920 in multiple countries, including the US, Germany, China and Italy. We're also closing orders for our upgraded aeroderivative gas turbines and newly-launched diesel products. Investment in our flagship gas turbine, the LM6000, will increase output and efficiency, and our upgraded LMS100 offers more than 10 MW of additional power for customers. We also launched our first diesel engine in 2014 with Flour Mills PLC of Nigeria, and this product will help meet demand in the large diesel power segment.

This year, we're doubling investment in the services business through expanded conversions, modifications and upgrades (CM&U) offerings to help current customers achieve more productivity and get more out of their installed units. We also will continue to grow our Predictivity software solu-

tions that use the Industrial Internet to help customers deploy their assets better. We have delivered more than 37,000 Distributed Power products around the globe, so our investment in services will provide better solutions for all of our existing customers as well as future ones.

WORLD-GEN: BACK IN JUNE, WORLD-GEN ATTENDED YOUR LAUNCH EVENT FOR THE J920 IN DENVER, YET THERE HAVE BEEN NEW SALES IN EMERGING ECONOMIES AS WELL — WHERE IS GE FOCUSING ITS DISTRIBUTED POWER BUSINESS?

Lorraine Bolsinger: There is not a single macro-strategy for our business to grow globally – instead, we have a country-by-country approach for Distributed Power due to the variety of customers and applications. We define 'distributed power' as "power generated at or near the point of use on or off the grid," so our business addresses many different segments. Our two primary applications are oil & gas and power generation, but there are many diverse segments within these broad categories. For example, distributed power for oil & gas applications includes drill rig power, pipeline compression and LNG. Power generation applications include base load power, cogeneration or CHP, peaking power, and emergency power. CHP serves industries as diverse as textiles, breweries, and universities, so we certainly don't have a 'one size fits all' segment approach.

The majority of opportunities for power generation reside in emerging regions, but we continue to see opportunities in North America for gas-fired generation as well. Some applications, such as the power generation needs of data centers and hospitals, are ideally suited for CHP which can reduce costs and raise reliability for critical infrastructure in developed economies. In the developing world – where we are supported by GE's strong Global Growth Organization with local teams – economic instability and lack of fully developed infrastructure calls for technology that's easier to finance and faster to install, such as distributed power. These regions also need

localization of engineering and application support, and we have expanded our regional teams to accommodate those needs.

WORLD-GEN: SINCE GE LAUNCHED DISTRIBUTED POWER, WE'VE SEEN OTHER VENDORS AND COMPETITORS LAUNCH SIMILAR BUSINESSES. IS THE SPACE GETTING TOO CROWDED?

Lorraine Bolsinger: We think our competitors' actions validate our thinking – that there are huge opportunities for growth in distributed power – and we like the advantage we have to serve customers. We have decades of investment in technologies like aircraft engines, power generation, oil and gas drilling equipment and locomotives. In fact, our new 616 diesel engine is derived from a locomotive engine built by GE Transportation, and our aeroderivative gas turbines are built on the company's aircraft engine heritage of more than 50 years. Customers are able to take advantage of this broad portfolio, and they can also expect GE to continue investing in all these technologies for decades to come. So we think it's a big segment in power generation and we like our position in it.

WORLD-GEN: A LOT OF UNCERTAINTY REMAINS WITH THE DISTRIBUTED POWER MARKET POTENTIAL, PARTICULARLY WITH ONGOING DELAYS AND FINANCING ISSUES WITH NEW PROJECTS. HOW IS GE MANAGING THE 'SOFTNESS' OF THE INDUSTRY FOR THE NEAR FUTURE?

Lorraine Bolsinger: Even though there is some softness in the industry, we feel that the fundamentals of distributed power remain. There will be continued GDP growth and emerging regions will have increased desire for building out infrastructure, so we will keep investing. If we were to stop investing in power technology due to the industry's slower pace of growth, we would be placed at a

(continued page 22)

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WILLIAM BUFFA



*Senior Vice President & General Manager
Mitsubishi Hitachi Power Systems -
Energy and Environment, Ltd.*

Companies routinely create strategies to take advantage of situations they anticipate in the marketplace, or to deal with circumstances created by geopolitical events, economic disruptions and stricter environmental regulations. Such plans, though, aren't always carried out routinely. But that hasn't been the case for the Energy and Environment Division of Mitsubishi Hitachi Power Systems America (MHPSA-EE).

Since its establishment in 2005, originally as Hitachi's standalone operation supplying North American power generation companies with energy products and follow-up service, the Energy and Environment Division has developed a practical perspective on the way it implements its mission.

"We don't try to drive the market," says *World-Gen's* Class of 2015 inductee William Buffa, senior vice president and general manager of MHPSA-EE. Instead, Buffa explains, the Energy and Environment Division tries to understand what a power producer client wants to achieve and how it expects to reach its objectives. Is it converting to natural gas? Is planning retrofits with AQCS upgrades using new technology, designs and equipment to burn coal cleanly with lower emissions? Does it understand the regulatory climate and the ramifications involved in specific states and region? "We offer solutions," Buffa says.

This sort of strategic attitude reflects the fundamental principles and engineering doctrines that have guided two venerable

Japanese leaders in power generation technology – Mitsubishi Power Systems America and Hitachi Power Systems America – for a combined 150 plus years. And it is the blueprint that the recently formed MHPSA-EE follows.

Last February the two multinational industrial companies merged their fossil power generation businesses in North America with a plan to expand their power generation and related environmental product lines, service and factory capacity. From Buffa's viewpoint of more than 38 years in the power industry and ten years with Hitachi Power Systems, the merger was a natural fit.

Hitachi's sales and full service operations were solidly established in the North American solid fossil fuels market, he explains, supported by experienced engineers and technicians who knew the market and whom the market knew well. Buffa describes Mitsubishi with its combustion turbine expertise as probably having the most advanced rotating machinery/equipment technology in the business. With the combined talent and resources of Mitsubishi and Hitachi, superior technological products have become available to broader markets rapidly, cost effectively and with better project execution and service support.

And these products, equipment and systems couldn't have come at a better time. As pressure mounts from politicians, environmentalists and regulators to retire several hundred of the country's estimated 1,300 utility coal-fired boiler units, the power industry is coming up with advanced technology. MHPSA-EE executive and *World-Gen* Class of 2014 honoree Larry White said last year he had doubts about the wholesale scraping of one third of the U.S. boiler capacity. Instead, he noted it was more likely a number of these units could be converted to fire natural gas or undergo retrofits with AQCS upgrades using new technology – much of it developed by MHPSA-EE.

MHPSA-EE has indeed become a leading supplier of equipment and services for the power generation market. Products include advanced Pulverized Coal Boilers, Air Quality Control Systems, Wet Flue Gas Desulfurization, Enhanced All-Dry

Scrubbers, Fabric Filters, Mercury Oxidation Systems, SCR technology, Catalyst, Low NOx Burners and CO2 mitigation technologies. Services include Operation and Plant Performance assessments, Engineering Studies, Coal-to-Gas conversions, Pulverizer and Pressure Part modifications and replacements, Inspection, Commissioning and Start-up, AQCS upgrades and conversions and Spare Parts.

"We can supply the entire market," says Buffa. The newly integrated MHPSA is headquartered in Lake Mary, Florida, while the Energy and Environment Division (MHPSA-EE) is located in Basking Ridge, New Jersey. "This means we are not just a sales and marketing office for Mitsubishi and Hitachi Technologies," he goes on, "but have resident project execution, engineering and design professionals, and procurement and technology staff in New Jersey." Buffa adds that MHPSA-EE offers clients total solutions as a project execution company, delivering not only a state of the art technical solution but delivering it on time and on budget.

ABOUT MHPSA-EE:

The recently formed joint venture between Mitsubishi and Hitachi, MHPSA now offers a wide range of boiler services and products. This includes inspection services along with emergency support, outage planning and assistance, equipment replacement, repair and overhauls services. MHPSA also provides engineering studies to analyze operating or maintenance problems, evaluate solutions and provide the designs necessary to correct an issue.

ABOUT WILLIAM BUFFA

He joined Hitachi in 2004 and spearheaded project execution when Hitachi Power Systems America was established in 2005. Mr. Buffa is responsible for the day to day operation of this division. Mr. Buffa earned his Bachelor of Engineering and Master of Engineering degrees in Mechanical Engineering from Manhattan College. He is a licensed professional engineer in the State of New York.

EILEEN KAUFFMAN



*Vice President
Leads Travelers Renewable Energy Practice*

WORLD-GEN: PLEASE EXPLAIN THE MAY 2014 LAUNCH OF "TRAVELERS RENEWABLE ENERGY PRACTICE."

Eileen Kauffman: Travelers has been insuring the energy industry for a century and renewable energy for more than twenty-five years. We created the new Practice to improve the way six of our businesses support the rapidly changing and special needs of wind, solar, biomass, geothermal, hydro, clean technologies and co-generation. The enhanced coordination helps us to provide coverage for the full lifecycle, from research and development to manufacturing, construction and day-to-day operations. Renewable energy is one of the four key segments to Travelers Energy Practice, in addition to Oil & Natural Gas Exploration and Production, Power Generation and Supporting Industries such as manufacturing and construction.

WORLD-GEN: TRAVELERS HAS A FORENSIC LABORATORY IN WINDSOR, CT, PLEASE TELL US THE WORKINGS OF THE GROUP ON SOLAR AND WIND.

Eileen Kauffman: Travelers is the only insurance company with a 40,000-square-foot forensics lab. We employ engineers and scientists there who study a number of different topics including solar

and wind components, assemblies and installations to understand best practices, to accurately assess risks and, in the case of a loss, to determine the cause. The lab's employees share their research findings and recommendations with our clients, as well as with our risk control and underwriting experts, who use the insights to assess the risks of other sites. Our forensics lab is the closest thing the insurance industry has to CSI crime lab and is a great example of the sophistication, knowledge and experience Travelers brings to the renewable energy sector.

WORLD-GEN: IS TRAVELERS ALSO LOOKING AT BATTERY STORAGE AND BIOMASS?

Eileen Kauffman: Absolutely. We recognize battery storage as a tremendous opportunity and an emerging market. Travelers has the capabilities to write the full life-cycle of a battery storage system, from R&D, to manufacturing, to a fully operational system. Travelers also writes components of biomass, including the R&D, technology and construction phases.

WORLD-GEN: PLEASE LIST THE SERVICES OFFERED BY TRAVELERS RELATING TO PRODUCT LIABILITY, WORKERS COMPENSATION AND CONSTRUCTION CLAIMS.

Eileen Kauffman: Regarding product liability, we have specially trained claim professionals with intimate knowledge of the manufacturing, installation and technology processes associated with wind and solar energy.

Regarding workers' compensation, we are number one in the nation and have a number of patented innovations to control medical costs. We also have catastrophic case managers who can ensure appropriate and timely treatment for the most serious cases, including a fall from a wind turbine tower."

Regarding construction, we offer construction-related general liability and construction defect expertise as part of our national claim organization, which has 50 locations across the country. This is another example of claim specialization that dif-

ferentiates us from the competition. It may be hard to believe, but Travelers has approximately 12,000 claim professionals. So we don't just have general adjusters handling construction claims, we have a national claim organization to handle construction losses, and staff attorneys and forensic engineers with expertise in solar and wind.

Finally, we have specialized resources worth noting, from a mass tort team; over 500 on-staff nurses; staff counsel; an engineering lab; investigative services; more than 700 risk control professionals; and Claim University in Windsor, CT, that provides in-depth training to enable our claim professionals to provide knowledgeable, empathetic, and efficient claim service to our customers.

WORLD-GEN: PLEASE MENTION SOME OF THE PROJECTS TRAVELERS HAS WORKED ON.

Eileen Kauffman: We insure a wide array of projects, from 100Kwh wind turbines to 150Mwh wind farms with 100 GE turbines. In addition, we write many sizes of solar projects, from single-panel installations to large commercial rooftop and ground-mounted systems up to 5MW.

We are the second-largest writer of commercial U.S. property casualty insurance and have written coverage for various rooftop installations used by colleges and universities, and public and private K-12 schools to commercial real estate and to big-box retail operations.

It is worth noting that access to both capital and insurance have played a critical role in the ability of the renewable energy industry to grow over the years and that this access is equally important today, especially as the size of the investments increase.

WORLD-GEN: PLEASE DISCUSS TRAVELERS INVOLVEMENT WITH LOCAL COMMUNITIES RELATING TO SAFETY ISSUES ON COMMERCIAL SOLAR PANELS.

Eileen Kauffman: We encourage our customers to meet with their local fire

(continued page 24)

TOM ALCIDE



President
Saft America

Saft makes nickel-based, primary lithium, lithium-ion and silver-based batteries. Its batteries-nonrechargeable and rechargeable-meet customers demands for weight and size constraints and usage in varying climatic conditions.

The Industry Battery Group (IBG) manufactures rechargeable batteries for transportation, stationary backup power and energy storage systems. Nickel-based batteries represent the traditional expertise of Saft's Industry Battery Group, which has developed lithium-ion technology whose applications benefit from the smaller lighter, longer-life and versatile batteries that Li-ion offers.

The Specialty Battery Group (SBG) manufactures primary and rechargeable batteries for civil and military electronics activities, space and defense. Saft's Specialty Battery Group leads in the design, development and manufacture of high-performance primary lithium and lithium-ion battery systems (Li-ion).

Saft (Euronext: Saft) is headquartered in Paris with over 3,800 employees in 18 countries with 14 manufacturing sites and 30 sales offices.

SAFT IN US

World-Gen was invited to tour the LEED silver certified, 12 acre, 235,000 sq. ft. brownfield Jacksonville, FL facility, home to the world's most advanced lithium-ion battery factory. The fully automated plant has 4,340 solar panels generating a third of the plant's power requirements.

World-Gen interviewed Tom Alcide who shared the "building block process" of the Jacksonville factory.

"We have the capability to make cylindrical or prismatic cells that can be sold or put into modules," he said. "Modules can be multiple voltages for energy or power." The process continues when modules are installed in racking systems that can be put into containers. He explained the dry room operation which can be seen on a video on world-gen.com.

"One of the things we do is work with our customers to customize the products they need," Alcide said in conclusion.

2020 UNDER AB2514

Saft has received three contracts to deliver 7.5 MWh in 12 containers for energy storage systems (ESS) to a utility in California. California's investor-owned utilities are required to procure 1.3 GW of ESS by 2020 under AB2514, and Saft's well positioned for the planned 32 percent of distributed storage.

Under DOE ARRA funding, Saft was selected to expand the manufacture of advanced batteries for hybrid and electric vehicles.

Saft has developed the "Advanced Deployable Renewable Energy System," (ADRES) for the US Army. ADRES will power mission-critical equipment by storing energy produced by solar panels and wind turbines in a 28 V Li-ion battery.

Saft also delivered a 10 MW, ESS for a PV farm in Puerto Rico including a 10 year warranty parking package in the summer of 2014.

Saft is supplying an ESS for 12 MW's to Kauai Island Coop in Hawaii. The Saft battery system will store up to 4.63 MWh and provide 6 MW's of power.

SAFT IN CHINA

Saft Zhuhai batteries for industry has been serving the Chinese metering and Electronic Toll Collection markets through its advanced technology facility in Zhuhai since 2006. The factory has just passed an important milestone, as it has just produced its 100 millionth primary lithium battery.

SAFT SALES

Saft's 2013 sales were €624.2 million from 4 segments:

Transportation: back-up power for rail, aviation and industrial vehicle traction (22%).

Stationary back-up power: oil and gas sector, industrial facilities, telecommunications networks and energy storage (37%).

Civil Activities: powering utility meters and electronic toll collection for example, in space for satellites and space launchers (25%).

Military Activities: communications systems, torpedoes, missiles and military hybrid vehicles (16%).

RESEARCH AND DEVELOPMENT

Saft invested €55 million in R&D representing nine percent of sales with 70 percent going to lithium-ion technology now entering its third and fourth generation.

SUSTAINABLE DEVELOPMENT

Saft batteries are designed and made compliant with environmental responsibilities. Saft was the first battery supplier to carry out a full Life Cycle Assessment on primary lithium batteries for metering devices. Batteries are collected and recycled when possible.

SERVICES

Saft offers not only systems integration, but also full turnkey solutions that include installation, commissioning, operation, training, maintenance and supply of spare parts for its battery systems.

ABOUT TOM ALCIDE

Thomas Alcide is President of Saft America, Inc. and has been Director and General Manager of the SBG division since 2004.

Previously, he was the Director and General Manager of the group's lithium battery division from 2002 to 2004 and was the Director and General Manager of the Valdese Plant from 2000 to 2002.

LOU LAMBRUSCHI



*Marketing Communications & E-Business Manager
Parker Hannifin-Energy Grid Tie Division*

Lou Lambruschi explains why central inverters are intended for larger applications at higher voltage levels, so they are more likely to be self-contained and field-ready than string and microinverters.

In performing basic DC to AC conversion, they are similar to string and micro inverters, but central units are more likely to include advanced features like power factor control, reactive power on demand and revenue metering. Central inverters generally include robust fault ride-through provisions, allowing them not only to continue to operate through a fault, but also to offer grid support. Thanks to their larger size, redundancy can be designed into these inverters to offer continued operation even during a component failure. Users also benefit from the intrinsic lower cost per kilowatt of a larger inverter, which — combined with the right feature set and high efficiency — can result in a lower total cost of ownership.

Some manufacturers are incorporating liquid cooling technology in their central inverter models for a smaller footprint and little or no air filter maintenance. While water/glycol cooling systems are the most widely used, a two-phase evaporative cooling system with pumped refrigerant is emerging as an alternative. This results in a more compact and efficient system that removes a lot of heat with a little liquid. Such a system also minimizes consumable items like filters and coolant additives. This non-conductive system is also much safer

than mixing water with high-power electronics.

On the operational side, central inverters are evolving into more than just power conversion devices. Features that make the inverters more grid interactive increase their value to the owner as a dispatchable asset. Many models offer flexibility with dual operating modes, allowing the inverter to work equally well on command in grid-parallel or island mode. Improved monitoring and fault detection with a robust communication interface is another increasingly desirable feature.

Serviceability is also an important concern with central inverters. While a smaller inverter can be literally swapped out on site, central inverters have traditionally had larger and harder to access components. To counter this disadvantage, newer modular designs with lightweight interchangeable phase modules, capacitors, inductors and fans improve field serviceability. With an accessible, modular design, scheduled maintenance or even major repairs can be done in an hour or less — rather than several days. Preferably, all serviceable components can be accessed externally without requiring an operator to enter the inverter enclosure. External access panels also enhance safety and simplify permitting.

Central inverters tend to be most attractive options for ground-mounted installations that are 400 kW and higher, and when 1000-V or higher input capability is required. Central inverters designed and built with environmental sealing and self-contained cooling systems can be sited in desert or coastal conditions without needing housing. Central inverters with “smart” features are also desirable in situations that require energy management. Such central inverters can provide grid support with power factor control or by providing reactive power on demand.

As more renewable sources are deployed, grid power quality will become an increasing concern. There will likely be a corresponding demand for “smart” central inverters that can support the grid. We see a growing demand for devices that will meet both current and proposed industry regulations, and anticipate that this trend will continue.

PARKER HANNIFIN - ENERGY GRID TIE DIVISION

RESOURCES FOCUSED ON THE GLOBAL ENERGY MARKET

Parker Hannifin Energy Grid Tie Division is located in Charlotte, NC, and is part of Parker’s Automation Group. The division focuses its operational and global growth strategies on power conversion for renewable energy and on utility scale and micro-grid energy storage products and technology. Its products are used to support the rapidly expanding renewable energy market and the associated energy storage requirements needed to integrate renewable sources and to improve utility grid stability and quality. The charter of the division is to continue rapid development and accelerated growth of this emerging market for energy storage, solar power, wind power, and other fast growing grid tie systems.

The Charlotte facility includes manufacturing and test capabilities, as well as product design and project engineering. Field engineering and startup service are provided by a team of direct service engineers deployed regionally, and international support is augmented by Parker’s extensive network of global facilities.

Parker’s track record in energy storage includes installations beginning in 2008, and over 100 megawatts of capacity installed to date. Major projects include a 32 megawatt system at Laurel Mountain WV, an AES wind farm, and a 12 megawatt system in Chile at AES – Gener. Parker is a founding member of MESA (Modular Energy Storage Architecture) Standards Alliance, and provided MESA compliant power conversion equipment for the Snohomish PUD project.

Louis Lambruschi has worked in the field of electrical power conversion for over three decades with Parker and other firms. During his tenure with Parker, he has worked extensively in the field of grid tie inverters as applied to electricity storage and the harvesting of renewable energy. Lou earned a Bachelor of Science degree in electrical engineering from Rensselaer Polytechnic Institute in Troy, NY.



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THE ENERGY TRANSITION IS CHANGING EUROPE

Europe is undergoing unprecedented change in the way that it produces and delivers power generation. This energy transition – driven by the need for countries to decarbonise their economies – will fundamentally alter the future of the coal, gas and nuclear sectors, and expand the role of renewables, smart grids and electric vehicles, as well as give consumers an active role in the delivery of their electricity.

All this and more will be discussed at POWER-GEN Europe and Renewable Energy World Europe 2015. Join us in Amsterdam for Europe's largest gathering of power professionals. To learn more about these exciting events and information on your sales representative please visit www.powergeneurope.com or www.renewableenergyworld-europe.com or contact:

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DAN GIRARD



*Director, Renewable Energy and Energy Storage
Business Development
S&C Electric Company*

WORLD-GEN: HOW DID S&C ADDRESS FERC'S ORDER 755?

Dan Girard: S&C is tapping our vast experience in designing and deploying energy storage systems to develop solutions for fast regulation that meet each ISO's technical requirements, and maximize the benefits that can be obtained from the new payment compensation structure mandated by FERC Order 755. While PJM was the first ISO to establish a frequency regulation market structure that is well-suited for energy storage resources, S&C has been actively engaged with utilities, other ISO's, and other stakeholders to establish additional markets. For example, we have been talking to MISO for over a year about the benefits of a fast frequency regulation market, and they are now moving to set-up a new market soon.

In October 2014 we installed a 150-kW demonstration energy storage system that provides fast-response frequency regulation for the PJM market at our global headquarters in Chicago. The system is providing real and practical data on the technical and financial performance of energy storage systems, providing frequency regulation service under FERC Order 755. We are using this data to improve and advance our services and components for energy storage systems. We welcome customers and industry professionals to see how we are addressing FERC Order 755.

WORLD-GEN: IS ENERGY STORAGE THE SOLUTION FOR PROVIDING FREQUENCY REGULATION? ARE THERE OTHER SOLU- TIONS?

Dan Girard: Yes. Although energy storage is not the only method available for frequency regulation, it is the only one capable of balancing power supply and demand instantaneously, i.e., in milliseconds rather than tens of minutes. It is also the only solution that can be combined with additional applications, e.g. islanding, peak shaving, renewable integration, etc. Numerous reports from DOE national laboratories have identified electricity storage as one of the best methods for regulating frequency and increasing grid stability.

Other methods for providing frequency regulation are adjusting the output of power plants (ramping up and down) and demand response and generator inertia; but these solutions are not as accurate or fast-responding as energy storage resources, which limits their value in fast-response applications.

WORLD-GEN: HOW MANY HOURS OF ENER- GY STORAGE HAS S&C CONNECTED, WHERE ARE THEY AND WHAT'S S&C'S PERCENTAGE OF THE WORLD'S BATTERY ENERGY STORAGE CAPACITY?

Dan Girard: S&C has connected 146 MWh of energy storage and is responsible for 20 percent of the world's battery energy storage capacity. Our projects are or will be located in USA, Canada, UK, and Australia.

WORLD-GEN: HOW CAN ENERGY STORAGE HELP IMPROVE PLANT PERFORMANCE?

Dan Girard: In the case of power plants, the spinning reserve requirements of electric power systems lead to power generation units running below rated values, which increases fuel and water consumption and CO₂ emissions. Energy storage can help improve the performance of power plants and thus increase overall efficiency of the power system by accommodating some of the spinning reserve

requirements. This functionality is well remunerated in some ancillary services markets, representing a source of revenue for the owners of energy storage facilities providing spinning reserves.

In the case of industrial plants, energy storage can preserve plant performance during costly power outages and power quality disturbances, the former by means of an islanding application, and the latter as a UPS. Energy storage can also help reduce the demand charges of industrial plants by reducing the peak demand (peak shaving).

WORLD-GEN: PLEASE GIVE EXAMPLES VALIDATING THE BENEFITS OF ENERGY STORAGE FOR INTEGRATING RENEWABLES.

Dan Girard: The first U.S. application of batteries as a direct wind energy storage device was implemented by S&C for Xcel Energy in 2009. The battery installation is adjacent and connected to a nearby 11-MW wind farm owned by Winwind Energy, LLC. S&C installed a sodium-sulfur battery along with the S&C PureWave® Storage Management System (SMS), our utility grade power conversion system. The system is able to store about 7.2 MWh of electricity, with a charge/discharge capacity of 1-MW. When fully charged, the sodium-sulfur battery is able to power about 500 homes for over seven hours. When the wind blows, the batteries are charged; when the wind calms down, the batteries supplement the power flow. The project is located in Beaver Creek, MN, about 30 miles east of Sioux Falls, SD.

- The PNM Prosperity Energy Storage Project is the nation's first utility-scale grid-tied solar energy storage system. A total of 2,158 solar PV panels producing up to 500 kW are adjacent to the S&C PureWave SMS®, which is integrated in to two different types of lead acid batteries. The two different types of lead-acid batteries are designed to collect and store the sun's energy during peak production times and dispatch it when production dips due to cloud cover or fading daylight. The first type is an advanced lead-acid battery that has been

(continued page 24)

SCOTT HENNEBERRY



Vice President, Smart Grid Strategy
Schneider Electric

WORLD-GEN: SCOTT, WOULD YOU LIKE TO TELL US ABOUT THE SMART GRID AND WHAT YOU'RE DOING AT SCHNEIDER ELECTRIC?

Scott Henneberry: We have had a focus on the smart grid and understanding what should be Schneider Electric's unique value to our customers, and so therefore we've taken a consensus of our business and our customers and we've said that the smart grid encompasses the use of energy and the way it's changing, all the way from generation to consumption. So rather than just say, as many companies would, that the smart grid is limited to utilities, or the transmission of electricity, we say it's all the way down to consumption and that means, for Schneider Electric, that we believe the smart grid will require new interactions between supply and demand. There's now a market in the US for demand response, as well as a growing market internationally. Utility operators and the balancers of the grid are now focused on putting commercial plans in place to incent end users to reduce power during times of peak usage, so that everyone can save money and improve grid reliability. For example, we're seeing the growing adoption of micro-grids on the part of end users for the sake of resiliency or for the sake of carbon reduction or even just for the sake of economics. Schneider Electric had been involved in the development, the implementation and the operation of micro-

grids for a long, long time. We just didn't know they were called micro-grids until a couple of years ago. Depending upon the type of industry they're in and the use of those micro-grids by local utilities to solve problems on the grid the micro-grid could be called a virtual power plant.

WORLD-GEN: ON THE MICRO-GRIDS THOUGH THERE'S ISLANDING AND STORAGE, IS SCHNEIDER ELECTRIC LOOKING AT STORAGE?

Scott Henneberry: Absolutely. We have a number of pilots currently in process both in Europe and the US that look at how energy storage can be used to smooth the grid, how it can be used to make more efficient renewable energy. Intermittent renewables can use storage to be much more efficient. We do not have today a business around the sale of energy storage and we are working with a number of partners in these pilots. We believe that storage will be an integral part of a number of the solutions that we bring to market, both for utilities and for end users. We may or may not get into the storage business but that doesn't mean that we won't use storage as an important part of our solutions.

WORLD-GEN: CAN YOU MENTION WHOM YOU'RE PILOTING WITH?

Scott Henneberry: Yes. In Europe we have signed an R&D agreement with Areva to develop a new energy storage solution called a flow battery. We also have some pilots in Europe and the US with some lithium ion manufacturers. We do have a partnership with Saft focused on small commercial and industrial customers to understand better how a commercial or industrial customer, potentially with renewable solar on the roof for example, could use energy storage to help balance out renewable energy and take better economic advantage of the tariffs that are used. That initiative is called our "Prosumer" initiative.

Through our sub-station automation business, we have recently released and are now actively implementing "the renewable production controller." It's basically an

embedded controller that is able to look at the dynamics on the power system of a lot of renewable sources. You could have wind, you could have solar, you could have some energy supply, and integrate those things for a better, stable supply.

We also have a big business around Electric Vehicle charging to help build out the charging infrastructure and encourage mass adoption of EVs. So we have several partnerships around how they can use those energy storage vehicles to help the grid.

WORLD-GEN: YOU MEAN TO RECHARGE ONTO THE GRID?

Scott Henneberry: Yes. There are a couple of architectures that are proposed with electric vehicles. One is called "vehicle to grid", V2G, in which plug-in EVs can communicate with the power grid to sell demand response services by delivering electricity into the grid or adjusting their charging rate to the vehicle in order to alleviate a grid peak. Another is called "vehicle to home," V2H, in which power can be delivered straight to the home through an EV battery which could collect power during the night when electricity rates are lower. We have discussions and some pilots with various folks to explore those options. We also have some discussions to see if the batteries that are being used for vehicles can be used in a separate application, stand alone stationary batteries to help the grid.

WORLD-GEN: FOR STORAGE?

Scott Henneberry: For storage, sure. One of the big problems that the battery manufacturers have is to scale, and getting the cost coming down with enough scale. Well, if you can find another application to help the grid that will pay for batteries, then the cost will come down that much faster.

WORLD-GEN: PLEASE TALK ABOUT SCHNEIDER ELECTRIC'S RECENT ACQUISITIONS.

Scott Henneberry: There's a couple of things that are new within the past couple of

(continued page 25)

BILL ARVAN



General Facility Manager,
Babcock & Wilcox's Palm Beach
Resource Recovery Corp.

The nation's first new waste to energy power plant to be built in twenty years is being constructed by Babcock & Wilcox and its consortium partner KBR on a 24 acre greenfield site for the Solid Waste Authority of Palm Beach. SWA is a governmental agency with 400 employees governed by seven elected County Commissioners of Palm Beach County and is funded by user fees through an annual property tax bill on the county's 1.4 million residents and businesses. B&W and KBR are sharing the design and work scope, while B&W will exclusively perform the operations and maintenance for the 95 megawatt facility expected to come online in Q-1-15. Florida Power and Light has a 20 year power purchase agreement.

The new plant referred to as PBREF#2 can process a million tons of municipal solid waste annually producing electricity and reducing the waste sent to the county's landfill by up to 90 percent. (Landfills generate methane which is 21 times more potent of a greenhouse gas than carbon dioxide.) B&W will supply three mass burn boilers, grates, ash and metal recovery systems and emissions control equipment with KBR providing the balance of plant equipment and construction services. The new plant employed about 700 during construction, will have 175 permanent staff and will also include a LEED Platinum Visitors Center.

The plant is adjacent to SWA's 52 megawatt PBREF#1 built by B&W and Bechtel in 1989. The Stirling boilers were replaced in 2010. "We'd typically do 860,000 tons; after the refurbishing, we did 900,000 tons," said Bill Arvan. B&W's operations and maintenance contract was extended to 2029.

Arvan, a chemical engineer who holds an MBA from Florida Atlantic University, explained the operation of the WTE plant and conducted a tour for *World-Gen* to point out the differences between Refuse Derived Fuel in PBREF#1 and the Mass Burn for PBREF#2. "On mass burn facility's, recovery of non-ferrous and ferrous metals is performed post-combustion. This differs from an RDF facility in which ferrous and non-ferrous metals are recovered both during the processing of MSW into RDF and post combustion," Arvan shared.

TIPPING POINT

"The fuel arrives on the tipping floor from six transfer stations hauled by SWA tractor trailers subject to 80,000 lb road limits. SWA receives about 500 loads a day or 1,000 trips daily," he said. Three procedures take place in the Refuse Derived Fuel (RDF) preprocess to remove hazardous materials, household materials and appliances before the conveyor carries it to the shredder. Overhead magnets sort out ferrous metals, recyclables and coins before going into the two Stirling boilers, he explained. The chemically inert bottom ash is combined with fly ash and sent to the landfill. Ferrous metals [contain iron] are sold to Trademark Metals who essentially nuggetize the material and ship it out on rail cars," he added. Non-ferrous materials are melted down and made into ingots. Last year, SWA sold more than 79,000 tons of recyclables and recovered coins accounting for \$100,000. SWA has recycled more than two million tons of residential and commercial material that otherwise would have been landfilled. In addition to recyclables, SWA recovers nearly 250,000 tons of clean vegetation annually which is mulched and either composted, processed into boiler fuel, or returned to the land as a soil amendment.

In answer to a question, he said the plant operates 120 hours a week and stores the fuel on site, though the power plant is operating 24/7.

The new facility will reduce 63 percent less carbon dioxide, 94 percent less sulfur dioxide and 62 percent less nitrous oxides that the traditional coal fired power plant. For every ton of municipal solid waste processed, one barrel of oil or ¼ ton of coal is saved and one ton of GHG avoided.

The facility will save 1.9 billion cubic feet of natural gas annually.

As the EPA has specific emissions limits for facilities that combust waste to produce energy, the Solid Waste Authority is incorporating the most modern and most sophisticated air pollution control systems of any facility of its kind in the world.

All of the emission levels from the PBREF#2 will be below the Federal standards, with the performance of the emissions control equipment guaranteed by the manufacturers and by the facility operator.

RECYCLING CREDIT

The State of Florida counts waste delivered to a Renewable Energy facility towards the State's 75% Recycling Goal, and the State provides one ton of recycling credit for each megawatt hour of energy produced.

There's a university-sponsored research program under way investigating the potential reuse of most or all of the ash currently being landfilled, just like ash from coal-fired power plants is used in the manufacturing of concrete. If this research proves successful, the life of the Solid Waste Authority's landfill will be dramatically extended, bringing it closer to the potential of zero landfill by 2046.

The SWA Conservation Area and Rookery provides over 300 acres of wetland habitat, harboring thousands of Florida wading birds, as well as two endangered species, the Snail Kite and the Wood Stork.

There are 86 WTE Plants operating in 24 States.

STEPHANE DUFRENNE



President
Upsolar America

WORLD-GEN: PLEASE EXPLAIN UPSOLAR'S 20-YEAR, ENERGY FREEDOM LOAN PROGRAM IN CALIFORNIA AND ARIZONA.

STEPHANE DUFRENNE: The Energy Freedom Loan is a unique turnkey financing solution. For homeowners, the loan program is designed to remove common financial barriers to solar adoption, like high upfront costs and unfeasible terms. With the Energy Freedom Loan, homeowners can invest in a rooftop installation for zero money down, with flexible terms, and repay over as many as 20 years. Each Energy Freedom system is built with high-quality equipment and is supported by long-term operations and maintenance services.

WORLD-GEN: IS THERE A CAP ON THE AMOUNT OF THE LOAN, WHAT'S THE INTEREST RATE, IS THE LOAN TRANSFERABLE AND IS THERE A PREPAYMENT PENALTY?

STEPHANE DUFRENNE: The Energy Freedom Loan is available in amounts up to \$65,000. Payments remain fixed—as low as 5.99 percent—even as electricity prices fluctuate, which results in greater savings for the customer over the lifetime of the loan. We impose no prepayment penalties, so as soon as the loan is paid off, energy generated by the PV sys-

tem is completely free!

Of course not everyone plans to stay in the same home for decades to come. In the event of a move, customers can simply transfer the remaining loan amount to the new homeowner.

WORLD-GEN: WHAT ARE THE KEY BENEFITS FOR INSTALLERS?

STEPHANE DUFRENNE: The Energy Freedom Loan program provides installers with an additional revenue stream and eliminates cash flow and support chal-

lenges encountered in some other third-party loan programs. Installers in our Energy Freedom network pay no out-of-pocket expenses for equipment, and see no dealer fees during transactions. We also connect installers with a seamless credit approval process and offer quick payment for completed deals, allowing our partners to spend less time doing paperwork and more time on the roof. In the event of any issues, installers can always count on expert guidance from Upsolar's dedicated support team.

(continued page 27)

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STEPHEN WIERZBICKI



President
Nutmeg Mechanical Services, Inc.

GEOTHERMAL HEATING AND COOLING: IS THE TECHNOLOGY BOTH ECONOMICAL AND GREEN?

Thinking of switching to a geothermal heating and cooling system? According to Stephen Wierzbicki, president of Nutmeg Mechanical Services Inc., check if your house is appropriate for geothermal before considering the investment. Determining if your house will benefit from a geothermal heating and cooling system depends on its location, size, and most importantly how insulated it is. If your house meets the necessary criteria to benefit from a geothermal heating and cooling system, then evaluate financing options, the geothermal equipment costs versus traditional heating and cooling systems, the associated annual utility cost savings, and the immediate environmental benefits from installing a geothermal system in your home.

Nutmeg Mechanical Services Inc. is a company that has been servicing and installing heating and air conditioning in Connecticut since 1982. The company started installing geothermal systems after a client asked about it in 1985. For 19 years, Nutmeg has grown to be one of the top performing geothermal heating and cooling contractors in Connecticut. To date, they have installed over 1,000 units and service the needs of a few thousand repeat customers in the Connecticut area. Most of the clients they serve need a new heating and

cooling system in an existing home. The company also serves clients who wish to install geothermal in a newly purchased building/property and partner with ENERGY STAR when installing geothermal and solar systems.

GEOTHERMAL WON'T FIX YOUR HOUSE

The most important factor in evaluating whether a geothermal system will effectively heat and cool your home lies in a home's ductwork, windows, and structural insulation. Since the geothermal system consistently provides more gradual heating temperatures and cooling temperatures than conventional HVAC systems, it is critical that the house does not lose the hot/cold air too quickly. This condition can actually be more comfortable because you don't experience the blasts of hot/cold air as the conventional systems. Prior to agreeing to install a geothermal system, it is critical to know the thermal capacity of a home.

As part of the company's services, Nutmeg offers an assessment of each home's ability to retain comfortable temperatures through numerous tests including, but not limited to, a blower door test and a duct blaster test on the existing duct system. In order to recommend insulation upgrades or window replacement prior to system installation, the company checks insulation values of your home's exterior and inspects a home's windows to see their level of efficiency. After the geothermal system is successfully installed, Nutmeg performs a start-up test to check the efficiency of the geothermal system and to be sure it is operating as efficiently as possible.

WHY NOW: TAX INCENTIVES, FINANCING, RISING PRICES AND UTILITY SAVINGS

After one determines his or her house is properly insulated for a geothermal system, he or she must do a cost benefit analysis of whether a geothermal system is worth the investment. First, look at the financing options available from the federal, state, and local government to help curb the cost of installment. There is a utility program in CT that grants a \$1,500 rebate if the home and system installed are tested

and meet manufacturer's guidelines. In addition to this rebate, the government offers a 30% tax credit to all home owners who install geothermal. Still don't have the capital to invest? Many home owners take out a home equity loan, a HUD Title 1 loan, or a private loan. The home equity loan is the most popular right now because it allows the homeowner to utilize the equity within a home to purchase improvements that maintain and improve a home.

After the homeowner assesses current financing options, he or she must consider the potential that the costs of geothermal equipment may rise and decide if it's better to install a system now or wait a few years. A common misconception is that the major investment in a geothermal system is the process of installation. However, studies conducted by the Greenbuildingadvisor.com show that the majority of the installation costs come from the geothermal equipment installed rather than the installation itself. Many geothermal contractors, like Nutmeg, have to adjust their pricing to the rising cost of equipment in order to stay somewhat profitable and remain in business. On top of the rising cost of equipment, similar to many businesses, labor costs and insurance costs rise with each passing year so the price of geothermal is not expected to drop in the coming years.

One of the largest incentives to installing a geothermal system is utility cost savings. Vendors and contractors will attest to the fact that today, if a family uses 1,550 gallons of propane a year without geothermal and 22,420 kwh in electricity with geothermal, a family saves roughly \$4,403.79 a year (This assumes propane costs \$3.18/gallon and electricity costs 12.3 cents/kwh). Geothermal also has a low life cycle cost in comparison to a propane furnace. The average furnace will last 7 to 10 years while geothermal systems are typically good for 15+ years. The ground loop used for the geothermal system has a warranty of 50 years and is made up of polypropylene pipe, the same pipe used in city gas lines. A study funded and completed by the Midwest Research Institute, National Renewable Energy Laboratory (NREL) Task Order No. KLDJ-

(continued page 26)

BRETT GALURA



*Vice President
AES Energy Storage*

AES launched its energy storage business six years ago with the commercial operation of AES Los Andes ES, a 24MW, lithium-ion based energy storage system located in the Atacama desert in northern Chile. Acting as flexible capacity, the spinning reserve function it performs is a common one. To many, it seemed like a technological leap yet the primary technology employed was far from new, lithium-ion batteries and IGBT based power conversion systems, both developed in the 1970's, began broad commercial adoption in the early 1990's.

Utilities that need new sources of reliability and flexibility today have a valuable "new" resource to turn to in energy storage. With open and competitive bids where flexible capacity is needed, storage can win competitively based on its merits. But today's challenge isn't limited to providing reliable electricity cost-effectively, but to do so sustainably. California, Hawaii, New York, and others are showcases for recognition of this need, each acknowledging the value of energy storage in their recent capacity requests.

This more recent mandate of sustainability adds tough criteria to an already restrictive set of filters. The underlying technologies must be proven ones and companies supplying those solutions must have financeable balance sheets that banks and insurers are comfortable with. Utilities seek to deploy resilient systems that can handle circumstances planners may not be able to

model or anticipate. This will translate to robust networks that are ready to absorb renewables at any level and to withstand unanticipated disruptions.

As an owner and operator of eight utility companies and over 30GW of generation in 20 countries, AES has served utilities and grid operators reliably and dependably for over 30 years. AES has a proven record of developing and financing power projects, matching appropriate technology to meet customer needs.

Consistent with this experience, AES has developed and operates over 200MW of lithium-ion battery based energy storage resources and, as the leader in utility scale commercial energy storage, continues to develop and offer energy storage solutions to utilities globally.

STORAGE IS THE ENABLER

According to the US Energy Information Administration (EIA), in the next 10 years the US electric sector will spend over \$25 billion on new resources to meet needs for reliability and increased needs for flexibility. Most of these capacity additions will come in the form of natural gas fueled simple-cycle combustion turbines which typically operate for fewer than 7% of all hours in a year due to their relatively high operating costs.

Energy storage—as a cost competitive provider of flexible capacity—can be dispatched immediately, has no emissions when operating, has no standby costs, can be located to strengthen natural weak points, and can be operated to manage and balance supply and demand since it is a source of both generation and load. No other resources in any combination can accomplish these critical tasks as quickly, reliably, and cost effectively.

When located strategically, utility scale energy storage systems can dramatically increase grid reliability and eliminate the possibility of large, and potentially, cascading blackouts caused by transmission faults and generator trips. AES Los Andes ES provides evidence of this. Since beginning operations, the 24MW facility has helped to eliminate an entire layer of load shedding in SING, the northern grid of Chile.

Today, lithium-ion battery based energy storage solutions exist, built on mature, technology with costs under \$1000/kWh—on par or better than a prior generation of solutions—due largely to the scale and maturity of their manufacturing.

Batteries differ significantly. Battery based energy storage systems are free from the constraints of peculiar geologies and pre-existing conditions and can be located exactly where they are needed to support grid stability. They can be scaled to any size needed, quickly, or over time to match changing needs. Built in factories for decades, batteries are not new, but are emerging as the star of commercial energy storage.

While new technology development must continue, much of it does so against an ocean of R&D in the lithium-ion industry which already has massive revenue from consumer electronics and transportation and several decades head start in scale and practical experience.

Prudent, progressive, and smart utilities are choosing lithium-ion based energy storage solutions because, as a technology, lithium-ion has nearly 25 years of commercial use and is approaching nearly a half-century of research and development. It is estimated that between 2 and 3 billion dollars per year are spent on lithium-ion R&D which is likely to increase over the next decade thanks to the combined interests of consumer electronics, automotive, and power industries. Lithium-ion is established, yet its research is broad, with academia and the private sector both contributing significantly. No other power technology is available which shares its development costs with similarly massive global industries.

Of the choices among battery based energy storage, only lithium-ion is mature, cost competitive, produced at scale, and financeable.

While lithium-ion technology is mature, solutions from experienced power industry companies are needed. Solutions must be integrated with existing utility operations, not only technically, but in a manner consistent with existing operational practices.

JIM GREENWOOD



President and CEO
Biotechnology Industry Organization (BIO)

The Hon. James C. Greenwood is President and CEO of the Biotechnology Industry Organization (BIO), headquartered in Washington, D.C. BIO is the world's largest trade association representing biotechnology companies and academic institutions across the United States and in more than 30 other nations. BIO members are involved in the research and development of innovative healthcare, agricultural, industrial and environmental biotechnology products.

Since his appointment in January of 2005, Jim Greenwood has markedly enhanced BIO's capacity, increasing both its staff and budget by nearly fifty percent. Under Jim's leadership, BIO has grown into a world-class advocacy organization playing a leading role in shaping public policy on a variety of fronts critical to the success of the biotechnology industry at the state and national levels as well as internationally.

The trade association comprises four organizational sections, one each for healthcare, emerging, agricultural and industrial biotechnology companies. BIO's industrial biotechnology section is the only trade association that brings together the entire value chain of renewable chemical and biofuel production – from dedicated energy crop developers, to technology providers, to biofuel and renewable chemical producers, to downstream consumer product manufacturers. BIO also hosts several

conferences each year that focus on fostering partnerships between companies across the bioeconomy value chain.

“One of the most rewarding parts of my job is working with business and science leaders across our industry; men and women whose vision is rivaled only by their passion to transform the way our planet produces energy and the way millions of products are developed and manufactured,” Greenwood says. “Around the world, we’re seeing significant job creation and sustainable economic growth as the biobased economy expands.”

The industrial biotechnology sector works toward a vision of integrated biorefineries that make multiple products from biomass, the same way oil refineries make multiple products from petroleum. Biorefineries that use industrial biotechnology can lower manufacturing and production costs, reduce or prevent pollution at the source, and enhance resource conservation. Building a bioeconomy therefore can revitalize traditional manufacturing in the U.S. or create new manufacturing opportunities by leveraging America's

(continued page 27)

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create new value chains*

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Biotechnology Industry Organization

STEWART PRAGER



*Director
Princeton Plasma Physics Lab (PPPL)*

PPPL is looking forward to reopening the National Spherical Torus Experiment after “stellar” progress in the \$94 million upgrade of the facility that should allow it to be completed this year, according to Stewart Prager.

NSTX-U is the experiment at the heart of PPPL’s research activities and will make the facility the most powerful tokamak of its type in the world. The two main components of the upgrade, Prager said, are the center magnet or center stack, and a second neutral beam that injects neutral atoms into the ionized gas or plasma to heat the plasma to temperatures of about 100 million degrees Centigrade. Those components will double the current, double the heat and quadruple the duration of the plasma.

“We’re building a scientific tool for the country and the Laboratory and there’s been great progress over the last year,” Prager said. “To date, every technical challenge has been met and there have been many of them.”

The neutral beam is in place in the NSTX and the center stack was inserted into the vacuum vessel of the device in October. The center stack magnet is really two magnets in one: copper bars that go straight up and down create one magnetic field and a coil around the center stack is a second magnet that drives a current through the plasma. It was constructed in four quadrants, which were then assembled and insulated.

“This requires incredible engineering

and craftsmanship and it’s gone extremely successfully,” Prager said. “We’re 85 percent in completion of the upgrade.”

The U.S. Department of Energy has strongly supported the NSTX-U project despite the ups and downs of federal funding, Prager said. “This is a fantastic result for this year and I hope next year we’ll be talking about the initial experiments on the NSTX-U,” Prager said.

The NSTX-U will allow researchers to produce “a sustained high pressure plasma” over the next decade, Prager said. Researchers also hope to discover “novel solutions” for the plasma material interface, the material inside the machine facing the plasma. That will be an essential task not only for PPPL but also for developing magnetic fusion in general, Prager said.

A smaller device, PPPL’s Lithium Tokamak Experiment, has been operating with a liquid lithium surface and has had “very favorable results,” Prager said. One long-term goal is “to have LTX become more integrated into the NSTX-U program,” he said.

ROLE IN ITER

The next step in developing magnetic fusion as a clean, abundant and safe energy source is the international fusion experiment ITER in Cadarache, France. PPPL is strongly contributing to ITER, Prager said. The Laboratory is designing diagnostic port plugs for the ITER tokamak and is responsible for purchasing and delivering 75 percent of the facility’s steady-state electric network, which will provide power for all steady state electrical uses at the ITER site. In addition, research conducted on the National Spherical Torus Experiment Upgrade, PPPL’s major fusion experiment, will produce valuable findings for ITER.

Prager noted that Richard Hawryluk returned to PPPL after working on ITER for two years as Deputy Director General for the Administration Department. Hawryluk received a certificate of appreciation from U.S. Secretary of Energy Ernest Moniz.

Researchers are looking ahead, Prager said, to a fusion nuclear science facility that could eventually lead to a demonstration plant. PPPLers are involved in preliminary

research investigating that possibility, Prager said.

The Laboratory’s theory and computation research is also essential to the Laboratory, Prager said. Last year, PPPL researchers were awarded 270 million hours on supercomputers to study the plasma edge, the equivalent of more than 20,000 years of computer time, Prager said.

BUDGET UPS AND DOWNS

The national budget for fusion energy research has been a “roller coaster ride for the research program,” Prager said. After dipping from 2012 to 2013 it was back up to \$306 million for research in fiscal year 2014 and increased again in 2015 to 317.5 million. At the same time, the ITER construction budget decreased to \$150 million from \$200 million the previous year.

PPPL’s funding from DOE’s Office of Fusion Energy Sciences (OFES) also dipped from 2012 to 2013. The FY 2014 estimated budget for PPPL totals \$96 million, including \$80 million from OFES. PPPL’s final budget for fiscal year 2015 has not yet been decided.

The good news is that the 2015 budget includes an additional \$25 million for infrastructure improvements, as part of an overall campus plan. “This is fantastic,” Prager said. The plan would consolidate all of PPPL shops into one building. It would also update PPPL’s laboratories, particularly for smaller experiments; modernize office spaces, and upgrade the Lab’s electrical and mechanical infrastructure.

OTHER NEW EXPERIMENTS & COLLABORATIONS

In addition to PPPL’s main experiment, the Laboratory has also moved ahead with several new experiments and collaborations, Prager said. One such facility is a new version of the Magnetic Reconnection Experiment called FLARE to study magnetic disturbances that cause northern lights solar flares, geomagnetic disturbances, and numerous astronomical phenomena. FLARE will be three times bigger and much more powerful than the current

(continued page 27)

DR. H.R. HUINIAK



Assistant Professor,
Eindhoven University of Technology - The Darcy Lab

AMBITION & AIM

The ambition is to realize a stable and affordable compact thermal battery for loss-free heat storage. TCM's (Thermo Chemical Materials) seem to be the most promising route for realization of such a battery. The concept of most TCM is based on (de)hydration or oxidation/reduction reaction of inorganic crystals. A typical example is the hydration of MgSO4. The aim is to boost the development of appropriate TCM materials for compact seasonal heat storage or low temperature waste heat.

DRIVERS OF THE INITIATIVE

Driver 1: Built environment - In 2020, 48% of the energy consumption will be thermal energy. There is an unbalance between heat production, (not needed in the summer) and heat consumption (needed in the winter). A heat battery could solve this problem. It enables local solutions for heat production and consumption and reduces the need for transportation.

Driver 2: Low temperature waste heat – A large amount of the industrial heat production is emitted to the environment. A stable and compact heat battery could facilitate storage, transport and trade of thermal heat.

CHALLENGES WITH TCM'S

Improving the energy density of TCM materials: Compact storage demands small

volumes and high energy densities. The most promising materials have intrinsic energy densities around 1-3 GJ/m3. The effective energy densities are generally lower, because optimal heat and mass transfer demand specific reactor geometries. Improving the lifetime of systems with TCM materials: The most promising class of TCM materials for the built environment are salt hydrates. Hydration/dehydration reactions involve volume changes that destabilize the material. Stabilization of TCM's is a key issue.

Tuning Power: Depending on the application there are different specifications regarding the rates of (dis)charge. To tune the kinetics the interplay between the solid-solid reactions in a TCM and heat/mass transfer has to be known. The heat conductivity of the TCM materials itself and the TCM-conductor interfaces have to be improved.

Safe Operation Window: As the aim is to develop a battery for a dwelling, the operations have to be done not far from the ambient pressure and at moderate temperatures. A key to the success of TCM's will be the ability to tune phase behavior into the appropriate window.

CONSORTIUM

A Dutch multidisciplinary consortium is now initiating research activities to tackle the challenges above. Within this consortium the Eindhoven University of Technology plays a coordinating role. Included are the energy technologists and transport physicists of the Eindhoven University of Technology, solid-state and theoretical chemists of the Radboud University (Nijmegen).

ABOUT DR. HUINIAK

Dr. Huiniak is an Assistant Professor at Eindhoven University of Technology in the Dept of Applied Physics/group Transport in Permeable Media (TMP). His research expertise is the transport of molecules through (porous) materials/imaging with NMR and modeling. He is active in cooperation with several universities to develop a "heat battery" for the built environment (seasonal heat storage).

PUBLISHER'S LETTER
CONTINUED FROM PAGE 3

and balance supply and demand since it is a source of both generation and load, outlined on page 18.

Jim Greenwood says on page 19 the industrial biotechnology sector works toward a vision of integrated biorefineries that make multiple products from biomass.

Stewart Prager projects on page 20 the next step in developing magnetic fusion as a clean, abundant and safe energy source is the international fusion experiment ITER.

Dr. H.R. Huiniak relates on page 21 that the aim of the Darcy Lab is to realize a stable and affordable compact thermal battery for loss-free heat storage. The concept of most TCM is based on (de)hydration or oxidation/reduction reaction of inorganic crystals.

EDITORIAL CALENDAR

May/June 2015
INTERSOLAR NA 2015
12TH REFF WALL STREET
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EDISON ELECTRIC INSTITUTE (EEI)
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RICH VOORBERG CONTINUED FROM PAGE 4

customer with options, aligned to their individual business needs. If they choose to take immediate action, we will be there with the parts and personnel ready to do the proper maintenance or repairs. If the data reveals that the issue is one that can wait with no risks, we'll help them schedule service at a time that will minimize interruptions. This approach works to reduce downtime and helps our customers manage costs."

Voorberg goes on to say, "Siemens is a large and experienced company; a global leader poised to meet both opportunities and challenges in the ever-evolving energy industry. Our goal within this regional group is to always strive for excellence. We are focused on being customer-centric, working alongside our customers every step of the way. We know that our customers know their business best. In addition, we are striving for consistent excellence across our whole product field, which is now quite extensive. I'm excited to be a part of this talented group at Siemens. I truly believe that we are very well positioned to meet the growing and changing needs of this market and to provide our customers with the highest levels of operational excellence."

ABOUT RICHARD VOORBERG

Richard Voorberg is Executive Vice President for Siemens Energy based in Orlando FL. As the lead for Service in Distributed Generation and Compression (DGC), his responsibilities include managing all aspects of service for Canada and the USA of Small and Medium sized Gas Turbines, Aero Gas Turbines, Intermediate Steam Turbines, Generators and Compressors.

Richard holds a Bachelor of Applied Science degree in mechanical engineering from the University of Waterloo, Canada.

LORRAINE BOLSINGER CONTINUED FROM PAGE 6

serious disadvantage with our customers. We can't take a season off if we intend to stay relevant.

In the meantime, we've found new ways to firm up the softness. We're creating new financing options to help customers who need them.

We have also invested in our mobile power units – the TM2500 -- which can be fast-tracked and installed in weeks, and we have a great rental partner, APR Energy, to provide these units for bridging.

Our turbines and engines can handle alternative fuels, which can be used in place of natural gas by customers who want to move to gas but don't have continued access yet.

So we are able to keep providing our best technology regardless of the industry's growth.

WORLD-GEN: GIVEN THE VOLATILITY IN THE ENERGY INDUSTRY, HOW WILL THE ALSTOM ACQUISITION SUPPORT GE'S OVERALL STRATEGY?

Lorraine Bolsinger: Everyone at GE is excited about Alstom's power businesses planning to join us later this year. We believe this will give our customers more access to some of the leading technology in the power gen and T&D segments.

Alstom's impressive geographic footprint in emerging economies will complement GE's footprint in the USA and Europe, so the positive impact this will bring for developing new technologies for global customers is clear.

Moreover, the rise of highly efficient combined cycle plants, coupled with the growth of renewable technologies, will allow our two companies to leverage our combined experience and engineering talent together.

WORLD-GEN: WHAT IS THE IMPORTANCE, IF ANY, OF THE AMERICAN EXPORT-IMPORT BANK ON THE VIABILITY OF DISTRIBUTED POWER'S SUCCESS?

Lorraine Bolsinger: Ex-Im is vitally important. Like other countries with export credit agencies, the United States has provided Ex-Im financing for decades, and we view it as a competitive advantage because we export 90 percent of our products. Although Ex-Im's charter has been extended through June, we support a full reauthorization to benefit GE and many other American companies.

A reauthorization would greatly benefit our employees and suppliers – we have more than 2,000 employees and more than 1,500 suppliers in the United States, and they are all critical to providing the materials and services we need to build our gas turbines and engines.

ABOUT LORRAINE BOLSINGER

Lorraine A. Bolsinger is President and Chief Executive Officer of GE Power & Water's Distributed Power business, headquartered in Cincinnati, OH, and employing more than 5,000 people around the world.

Lorraine joined GE in 1981 and has held roles in product management, sales and marketing across GE Energy, Aerospace and Aviation. In 1999, she was appointed vice president, GE Aviation Services Product Management.

She proceeded to the position of vice president, Aviation Sales, and in 2003 was named Chief Marketing Officer for Aviation.

In 2008, she became president and CEO of GE Aviation System. She is a member of GE's Corporate Executive Council.

Lorraine earned a bachelor's degree in Biomedical Engineering from the University of Pennsylvania.

KIMBERLY S. GREENE
CONTINUED FROM PAGE 5

for customers. And there is great value in this optionality.

For example, as weather-related demand and delivery challenges during last year's polar vortex caused natural gas price spikes in the Northeast, Southern Company dispatched one of the nation's most diverse and reliable generation fleets – delivering more than \$100 million in fuel cost savings by taking advantage of our fuel optionality.

By remaining committed to developing the full portfolio of energy resources – nuclear, 21st century coal, natural gas, renewables and energy efficiency – we will continue to balance the interests of our customers as we provide clean, safe, reliable and affordable energy.

WORLD-GEN: FOR THE LAST FEW MINUTES WE'VE BEEN TALKING ABOUT INDUSTRY ISSUES. AS FAR AS SOUTHERN COMPANY, ARE THERE ANY SPECIFIC CHALLENGES OR OPPORTUNITIES AHEAD YOU'D LIKE TO SHARE?

Kim Greene: While some say the industry faces an abundance of challenges, I see an abundance of opportunities. The same is true for Southern Company. And today we are using the latest technologies to develop the next generation of energy resources for the benefit of customers.

As Mississippi Power develops the Kemper County energy facility, Georgia Power is constructing two of the first new nuclear units to be built in more than 30 years at Plant Vogtle.

Nuclear will need to continue to be a dominant solution in a carbon-constrained future. It presents a solution to meet energy challenges while fueling the economy, preserving the environment and helping secure America's energy future.

Strategically developing the full portfolio of energy resources will be important to meeting our customers' energy needs in the decades to come.

WORLD-GEN: AS THE HIGHEST-RANKING FEMALE EXECUTIVE FOR ONE OF AMERICA'S LARGEST UTILITIES, WHAT ADVICE WOULD YOU GIVE TO OTHER WOMEN IN THE INDUSTRY HOPING TO CHART A SIMILAR CAREER PATH?

Kim Greene: I encourage women seeking leadership roles to make the conversation about their merits instead of their gender by consistently delivering quality work. In a broader sense, it's important that

employees at all levels push the envelope and challenge existing ideas and practices. We need to foster an environment where people are comfortable asking thoughtful questions.

The best way to stand out is to take on new roles and opportunities. This adds to your portfolio of skills, introduces you to different people – who often have innovative ideas of their own – and makes you a more valuable employee. In addition, showing you are interested in taking on additional responsibilities can help accelerate your career.



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EILEEN KAUFFMAN CONTINUED FROM PAGE 9

officials to confirm that their firefighters have been properly trained to handle a fire in a building with a roof-top solar installation. Ideally, our clients will conduct a thorough walk-through of the site with the fire officials that includes showing them the exact location of the rapid-disconnect switch for the solar installation, assuming one has been installed.

Travelers is also very active in industry organizations. For example, we are frequently asked to speak to risk managers for the nation's schools and universities who attend International Risk Management Institute (IRMI) conferences and work closely with those who influence safety codes and standards, including the National Fire Protection Association (NFPA).

ABOUT EILEEN KAUFFMAN

Eileen Kauffman is the leader of Travelers Renewable Energy Practice, responsible for coordinating the company's five renewable energy businesses.

Travelers Renewable Energy Practice underwrites risks related to multiple sources, such as wind, solar, biomass, geothermal, hydro, clean technologies, and co-generation.

Travelers provides solutions for the life span of a renewable energy business, from R&D and manufacturing to permanent operations.

Kauffman began her career at Travelers in 2006 as an underwriter for small business.

She was also a Business Development Director responsible for marketing, planning and execution across multiple middle market businesses.

She has more than 20 years experience in commercial property and casualty underwriting.

Kauffman studied at Penn State University. She is an avid cyclist and participates in two 150 mile rides every year to raise funds for multiple sclerosis.

DAN GIRARD CONTINUED FROM PAGE 13

enhanced with carbon to extend cycle life and is used for peak shaving. The battery collects electricity during the sun's peak production hours and discharges in the late afternoon when the sun is not as strong, but when power demand spikes. The second technology is a lead-acid ultra-capacitor hybrid system with good power capabilities that is used for solar smoothing. The battery collects and stores power and is then able to distribute it in spurts as clouds pass over. The project is located near Mesa del Sol, south of Albuquerque, NM.

- Catalina Island sits 22 miles off the coast of Long Beach California, and with no utility tie to the mainland, the island microgrid was served by Southern California Edison (SCE) through a combination of six diesel generators and 1.4 MW of micro-turbines. The diesel generators were deemed to be high emitters of mono-nitrogen oxide (NOx) gases by the South Coast Air Quality Management District, so SCE needed a solution that would allow the generators to run more efficiently, and thus reduce NOx emissions on the island. S&C was contracted by SCE to design, install, and commission a 1-MW PureWave® Storage Management System that would allow the generators to efficiently store and release power from the island's generators. This fast-responding automatic controller uses built-in intelligence to control charging and discharging of sodium-sulfur (NaS) batteries. The batteries provide large energy output over a long period of time, and the PureWave System allows the batteries to serve as both a load and a generator. The PureWave System can also provide power to the microgrid (up to the capacity of the batteries) if there is an issue with a diesel generator which prevents it from being brought on-line.

WORLD-GEN: WHERE DOES S&C MANUFACTURE PUREWAVE CES AND PUREWAVE SMS STORAGE SYSTEMS?

Dan Girard: We manufacture our PureWave CES and PureWave SMS storage

systems at our engineering and production facility in Franklin, Wisc. This facility supports S&C's power quality products, which include energy storage integration solutions (CES and SMS), reactive compensation systems applied at renewable energy plants (DSTATCOM), and extremely fast uninterruptible power supplies (UPS) for mission critical power users.

WORLD-GEN: DOES S&C OFFER A COMPLETE SUITE OF SERVICES FOR DESIGNING, DEPLOYING AND MAINTAINING THESE ENERGY STORAGE SYSTEMS?

Dan Girard: Yes. As a leader in integrating energy storage into the grid, we draw on real-world expertise to deliver successful energy storage projects, from the earliest stages of project evaluation and design (including financial assessment), to construction, system commissioning, life-cycle maintenance, asset management and monitoring from our Global Support and Monitoring Center. Our energy storage systems use S&C's field-proven power electronics technology to provide rapid response to changing system conditions. Our team is comprised of different groups including Analytical Studies, Engineering Services, Field Services, Laboratory Services, Project and Construction Management, Installation Services and Asset Management, offering a total solution approach to all areas of energy storage.

ABOUT DAN GIRARD

Dan Girard has over 25 years of technical and project management experience working with utilities, large commercial and industrial customers on various engineering solutions consisting of power issues that include design of substations, power feeders, power factor corrections, new building electrical layout, and campus layouts. These have included electric utilities, commercial plants, industrial plants, college campuses, hospitals, wastewater plants, and water treatment facilities. Dan received his BSEE in Electrical Engineering from Marquette University in 1984.

SCOTT HENNEBERRY

CONTINUED FROM PAGE 14

years that have come to us from acquisitions that directly involve the smart grid. For example, the Telvent acquisition included a micro-weather forecasting service. We're beginning to integrate this into our solutions for not just outage management, but even forecasting when cloud cover will obscure solar cells. So if you can have a very good short term forecast, say cloud cover that is only going to last a minute, don't start discharging the batteries. Or, this is going to last for 2 days so it's ok. We'll get a full cycle out of the battery. Then you can really increase the life of the battery. It's the kind of weather forecast that helps a utility give a load forecast for the following day. Weather is very important.

When we acquired Invensys, everyone understood that that was mainly used in our industrial business. We knew that Invensys operated some in generating stations because generating stations look a whole lot like industrial process plants, particularly thermal plants, but in addition Invensys has a very strong cyber-security practice. They do this for a lot of industries, but for the utilities, they have an ongoing audit capability and some tools that can be put in place in the factories and the generating stations such as PCS, process controls that protect against cyber-attacks.

There are some things that have been deployed and we're continuing to evolve them. So for example, the Advanced Distribution Management System (ADMS) from Telvent is already deployed in about 50 installations all over the world. From an electric distribution perspective, this is really state of the art modeling of everything on the distribution grid to do "what if" analysis and real time dynamics. There are a couple hundred ADMS applications we can talk about but there's one that's very intuitive that I like to point to and say, this is why it makes sense to have a smart grid, and this happens at ENEL, the state utility distribution grid of Italy. Eighty percent of the Italian distribution grid is modeled

through our ADMS.

To the extent you can balance how energy gets from point A to point B, you can save losses. Technically, line losses are equivalent to the square of the current going through a wire. If you have two wires going from point A to point B, you send 100 units of current through A and none through B, you have 10,000 units of losses. One hundred squared. If you split it up and you have 50 units going through both, you have 5,000 units of losses because it's twice 2500. So therefore, if you're smart enough to understand exactly where all your customers are and how much their loads are and where all your generation sources are, you can do all the optimization to figure out the best way to get the energy from point A to point B, then you can minimize losses. The problem is it's constantly changing in real time. So the model of the distribution system does that for ENEL and will give them a recommended list of switching operations that they can use. No customer knows this is going on. It's just a question of how the power gets to them, and ENEL saves about 5% of all the losses on their distribution lines, just from that one application of the ADMS. That's one of the more intuitive applications of the smart grid that I like to talk about. The ADMS is – to answer your question about are we rolling this out or is this coming out soon – the ADMS is already existing, we have 50 installations world wide, and we're adding more and more applications as we go forward.

WORLD-GEN: ARE YOU JUST WORKING WITH ELECTRIC UTILITIES?

Scott Henneberry: So that's the beauty of how we view the smart grid, as we were discussing earlier - yes we work with electric utilities, but we also work with end users. We have an energy and sustainability services business that works with end users to help them understand and save money in a retail market. We help them figure out an energy plan so they sign up with the right supplier, with the right tariff, with the right program for demand response, with real time rates or not, and then we can help them optimize

that. So we can give them renewables that they can sell.

WORLD-GEN: WHEN YOU SAY "THEM," WHOM ARE YOU REFERRING TO?

Scott Henneberry: They could be national accounts. For example, one of our largest accounts in the US is a nationwide cellular carrier. They have a cellular network that covers the entire US with facilities in every single one of the 3,000 utilities in the US. So solving the equation, what's the best way for me to buy and use energy for this nationwide cellular carrier is a pretty complex equation. We do that for them with our dashboards, and with our sustainability services.

We do that with a lot of end use customers. We give them advice as to what and how they should use their energy, how they should buy their energy, what programs, what smart grid programs they should participate in. So we can do both consulting and be a technology provider. We do both supply and demand and help facilitate those new relationships.

ABOUT SCOTT HENNEBERRY

Scott Henneberry has 30+ years in the Electrical Industry. During the first 20 years of his career he worked for Siemens, in various Marketing and Operational management positions after which he went to Power Measurement, Inc., a small high-tech company in the electrical industry.

Since the acquisition of PMI by Schneider Electric in 2005 Mr. Henneberry has focused on the strategic aspects of the Power Monitoring & Control business for Schneider, and most recently has been assigned to the global Corporate Strategy Dept of Schneider Electric responsible for defining and coordinating the implementation the Schneider Electric Smart Grid Strategy.

He also represents Schneider Electric as a Founding Board Member of the Research Triangle Cleantech Cluster and is a member of Greentech Media Grid Edge Executive Council.

STEPHEN WIERZBICKI CONTINUED FROM PAGE 17

5-55052-01 published at the Oregon Institute of Technology concluded that geothermal heat pumps (GHP's) have considerably lower operating and maintenance costs than existing alternatives. In that study, three HVAC systems were considered: (1) rooftop units with gas heat and expansion (DX) cooling (air cooled condensers) (2) air-source heat pumps (3) geothermal heat pumps. NREL reports, *"The GHP system is the most expensive to install, but the least expensive to operate and maintain. Rooftop units with gas heat and DX cooling are the least expensive to install, but the most expensive to operate and maintain. Air-source heat pumps have higher installation costs than gas roof top units, but do not save considerably in annual operating costs, mostly due to the significant amount of supplemental electric required in winter months."*

Although the propane cost savings are clearly evident, the efficiency of the geothermal heating and cooling system in even a well-insulated home is hard to measure. More field data is needed to truly assess the role of the geothermal system compared to the role of a well-insulated home in maintaining a comfortable indoor temperature. Some data on the internet is skewed in favor of the manufacturer's opinion of system efficiency in order to increase sales. One must do some homework and select the right contractor to decide whether his or her house is too big, too "leaky", or is located in too mild of a climate to assess the "efficiency" of a potential geothermal system in the home.

ENVIRONMENTAL BENEFITS: IS GEOTHERMAL ALWAYS GREEN?

Bottom line is; you have to heat your home some way. If you are interested in taking care of the earth, the environmental benefits might tip you in the direction of a geothermal system. According to "Geothermal Professionals", the use of a ground source heating pump system can save on average about 4 tons of CO2 per year. Installing a

three-ton geothermal system is equivalent to planting over 1 acre of trees or taking two cars off the road. The overall environmental benefits of geothermal are clear, geothermal does not directly emit carbon dioxide, carbon monoxide, or other greenhouse gases that contribute to climate change. While such a system (depending on the source of electricity needed to run it) can indirectly contribute to GHG emissions, the overall net emissions of GHGs are significantly less than traditional methods of heating and cooling a home. In addition, when looking at the environmental impact, one must also consider the potential consequences of installing an open loop geothermal system versus a closed loop geothermal system.

Most of Nutmeg's installs are vertical closed loop geothermal systems that can fit in almost anyone's backyard. Wierzbicki explains, "With a closed loop system, homeowners can set it and forget it." A closed loop system requires little maintenance after it is installed, uses less electricity to operate and does not release water or minerals into the ecosystem surrounding a home. Open loop systems need to discharge into a dumping ground and might change the water temperature of a nearby lake, well, or pond. The systems require a larger pump, which causes a homeowner to use more electricity. If a homeowner identifies minerals in the loop, he or she needs to add filtration to keep the pump clean. If the water level of the water source connected to the loop ever drops, a homeowner can run out of water.

THE FUTURE OF GEOTHERMAL HEATING AND COOLING

When deciding on whether to install a geothermal system or ground source heating pump, it is helpful to look at geothermal from an industry perspective. Where is the market for geothermal heating and cooling going and would geothermal be a sustainable heating and cooling alternative if subsidies no longer existed? According to Wierzbicki, *"In the new construction market, geothermal is going to grow and prosper. When the utility cost savings are weighed against an increased cost in mortgage, it is clear that geothermal is a good investment. In the retrofit market to existing homes with*

the 30% tax credit, I believe we will see a slight increase in demand to what we are seeing now."

However, Wierzbicki admits that without the tax credit, there will most likely be a large decrease in demand in both the new construction and retrofit markets for geothermal heating and cooling systems. He surmises, "If oil prices were fixed at 4 dollars/gallon or more and field data showed geothermal reduced operating costs by 60%, geothermal would stand as a strong heating and cooling alternative without subsidy."

When looking at geothermal heating and cooling in respect to other alternative renewable energy resources such as solar, Wierzbicki confirms, "If air conditioning is important, solar and geothermal do not compare." Only, geothermal effectively cools the home. Plus, the sun doesn't shine every day for effectively heating the home. According to Nutmeg, solar and geothermal complement each other rather than act as competitive alternatives. Wierzbicki suggests coupling a geothermal system with a solar electric field to save on your electricity bill while using the geothermal system. This will give the homeowner the lowest possible operating and utility costs.

If you are thinking of installing a geothermal system, it is best to do some research on your house first. Then assess your financing options, find a contractor that will be transparent about pricing and offers quality assurance, and weigh the environmental benefits of installing a closed or open loop system together with your expected utility cost savings. Even if you don't end up installing a geothermal system in your home, through this process, you will learn why your home gets so cold in the dead of winter and why you wake up sweating with AC blasting during the hottest summer nights.

ABOUT STEPHEN WIERZBICKI

Stephen Wierzbicki started Nutmeg Mechanical Services Inc. in 1982. Nutmeg aligned with the Comfort Institute Group and is BPI accredited to perform audits. Nutmeg is aligned with Carrier and its Energy Experts 360 program.

STEPHANE DUFRENNE

CONTINUED FROM PAGE 16

WORLD-GEN: WHAT EQUIPMENT IS INCLUDED AND WHAT GUARANTEES ARE PROVIDED?

STEPHANE DUFRENNE: Systems installed through the Energy Freedom Loan use Upsolar's PV modules and racking, and either string inverters from Solectria, or micro-inverters from APS. These high-quality components, installed by pre-qualified professionals, safeguard homeowners' investments from day one, ensuring peak performance and maximum electricity bill savings. Additionally, Upsolar products feature a 10-year workmanship warranty and a 25-year performance guarantee, as well as third-party Insurance protection from AIG.

WORLD-GEN: ARE THERE PLANS TO EXPAND FROM RESIDENTIAL TO COMMERCIAL MARKETS?

STEPHANE DUFRENNE: Projects in this space require much more tailored financing based on variables like site profiles and customers' electricity needs. We can offer financing on a case by case basis. However, we feel the residential market is ripe with opportunity and will maintain our focus in this sector for the time being.

WORLD-GEN: WHAT ARE UPSOLAR'S US GOALS AND WILL ENERGY STORAGE OPTIONS BE OFFERED IN THE FUTURE?

STEPHANE DUFRENNE: The early response we've seen in the California and Arizona markets has been extremely positive. We intend to expand our residential offering to additional states in the future. We will certainly consider complementary technologies like energy storage options as part of our offering down the line.

In the shorter term, we plan to focus on program enhancements like design services, which will enable installers to focus on their primary tasks—selling and installing systems—rather than worrying about procurement or getting credit lines with local distributors.

JIM GREENWOOD

CONTINUED FROM PAGE 19

strengths in agriculture and biotechnology. A growing bioeconomy would increase our energy security, improve the nation's balance of trade, improve the nation's environmental health, and generate high-quality jobs particularly in rural areas. The organization works closely with companies to ensure that they have the tools, the resources and the relationships to grow and succeed.

Over the past few years, industrial biotechnology companies have made great strides, Greenwood points out. Cellulosic and advanced biofuel companies are at a pivotal point in commercial development, with thousands of workers putting steel in the ground and plants coming online across the nation and around the globe. Renewable chemical and biopolymer companies are commercializing new processes and generating products at competitive prices. New technologies for food ingredients, cosmetics, pharmaceutical intermediates, fragrances and flavorings are emerging. The renewable chemicals market is projected to reach nearly \$84 billion in value in the next five years, with an annual growth rate of 7.7 percent.

"The biotech industry never has and never will be for the risk averse or those unwilling to look over the horizon and to put in the hard work," Greenwood says. "The amazing innovations of today that are better for our planet – such as fuels that can transform the dynamics of global politics – evolved from decades of scientific research. But biotech companies do what they do – they push the envelope of science and technology – despite the risks and the long odds, to be able to bring new and better things into the world."

Jim Greenwood represented Pennsylvania's Eighth District in the U.S. House of Representatives for six terms, from January 1993 through January 2005. A senior member of the Energy and Commerce Committee, he was widely viewed as a leader on health care and the environment.

STEWART PRAGER

CONTINUED FROM PAGE 20

device. It will be constructed over three years and will be funded through \$3 million from the National Science Foundation and \$1.2 million from Princeton University, Prager said.

PPPL also began the Center for Heliospheric Physics, a joint project with the University's Department of Astrophysical Sciences, where researchers will study the space surrounding the sun. There, violent space weather can interrupt cell phone service, damage satellites, and knock out power grids.

Researchers at the Laboratory have also pursued numerous collaborations nationally and internationally, including the Max-Planck/Princeton Center for Plasma Physics, a collaboration between Princeton University and the Max Planck Society of Germany.

PPPL researchers are also working on "fledgling" studies of plasma-based nanotechnology, Prager said.

Other technologies being investigated at PPPL include a plasma mass filter that could potentially be used to clean up large amounts of toxic waste. Researchers are also working on X-Ray imaging techniques that could have "enormous impact in a huge array of applications," Prager said.

PPPL and U.S. Department of Agriculture researchers are developing a technique that uses radio frequency waves to pasteurize eggs. Princeton University and PPPL researchers are also working on a method to verify whether nuclear warheads being decommissioned contain nuclear warheads.

"All of this diversity of activities does not add up to a huge pile of money," Prager said. "However, they lead to huge scientific creative activity at the Laboratory, so in that way they're incredible."

Prager noted that while NSTX-U has been under construction for the past three years, PPPL researchers have been busy analyzing previous data from the experiment and collaborating with laboratories around the world.

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